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Climate change belief, sustainability education, and political values: Assessing the need for higher-education curriculum reform

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ABSTRACT

Educational attainment is generally a strong predictor of belief in climate change, but prior research indicates that for political conservatives a college education is not always associated with increased belief. Conservatives in several countries, especially those in populist parties, have shown skepticism toward climate-mitigation policies and in some cases toward climate science. The study contributes to theories of environmental belief by examining two mechanisms for the low effect of the college education on climate belief for conservatives: selective exposure bias (students avoid courses that challenge their beliefs) and resistance to belief change (students reject or filter information that is incompatible with their political orientation). Using a survey of college-educated adults in the U.S., the study finds strong evidence for selective exposure bias and mixed evidence for resistance to belief change. Importantly, approximately one-third of conservative students who took a college course with climate-change content shifted from initial skepticism or uncertainty to a more confident belief. Moreover, exposure to an education with a core curriculum is associated with stronger belief. The study provides support for the policy goal of a curricular requirement for climate education, which can overcome selective exposure bias and, for some students, resistance to belief change.

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1. Introduction

Although there is scientific consensus that anthropogenic greenhouse gases have significantly affected the world's climate, awareness of the science varies across countries (Carle, 2015; Lee et al., 2015; McCright et al., 2016). Moreover, there is evidence that the development and implementation of policies in support of clean technology and reduced greenhouse-gas emissions have become more contentious in many countries. For example, in Australia, Brazil, Canada, the U.S., the U.K., and several countries in continental Europe, researchers have identified connections between conservative politics and the rejection of climate science and climate-mitigation policy (Gillard, 2016; Hess and Renner, 2019; Lockwood, 2018; Tranter, 2017; Young and Coutinho, 2013). Because these connections can influence national policy and commitments to global climate accords, it is important to develop research that improves understanding of how to maintain support for climate-change belief and policy.

This study focuses on one important dimension of the connection between conservative politics and climate-change policy: the relationship between belief in climate science and education. The importance of sustainability education in diverse national settings has been recognized not only because it helps to build the technological capacity for sustainability transitions but also because it contributes to the broad public understanding of and support for sustainability policies (e.g., Lozano, 2010; Lozano et al., 2013; Watson et al., 2013). This avenue of promoting global awareness of sustainability has also been recognized in international statements and declarations about higher education and sustainability (Lozano et al., 2013). Moreover, in research based on the Gallup World Poll, educational attainment was the strongest predictor of climate-change awareness at a global level (Lee et al., 2015).

Notwithstanding the recognized importance of education, the association between education and climate belief is different for people with right-of-center and left-of-center political views. Prior research has shown that people with a conservative political orientation tend to be more skeptical of climate science, and it has also shown that increased education is associated with greater climate awareness (Hornsey et al., 2016; Lee et al., 2015). However,

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the relationship is more complex for the relationship between a college education and conservatives, for whom a college education is not always associated with an increase in belief in climate change (McCright and Dunlap, 2011b; Krange et al., 2019). An implication of previous research is the need to understand better the puzzle of how the college education may or may not affect climate belief, particularly for conservatives. To address the puzzle, this study develops both a conceptual framework and empirical evidence that contributes to theories of the mechanisms that affect the relationship between taking climate-related courses in college, political orientation, and belief in climate change. In addition to developing new evidence and contributing to theory development, the study develops policy implications about sustainability in the higher education curriculum. Specifically, the study contributes to the broader discussion about how to embed sustainability education in higher education requirements, an issue that is of relevance to colleges and universities throughout the world.

2. Background

2.1. Theoretical framework

This study builds on and contributes to the influential, international theory in environmental psychology of relations between values, beliefs, and behavior, sometimes known as "values beliefs norms" theory (Dietz et al., 2005; Stern et al., 1999). The theory postulates a chain of connections whereby values held by individuals affect their beliefs with respect to environmental issues. In turn the beliefs have an effect on an individual's sense of obligation to act, as well as actual social action or behavior, including the norms and attitudes that are associated with specific categories of behavior. The environmental psychology framework does not examine why and how specific political values affect environmental beliefs; to answer this question, another causal factor needs to be introduced into the model based on societal shaping forces. For example, sociological research has documented industry influence on the media and on governments, such as spending by the fossil-fuel industry to weaken public awareness of climate science and to undermine support from political leaders for climate-mitigation policy (Brulle, 2018; Dunlap and McCright, 2011). Likewise, communication research has indicated that the rise of social media may contribute to political homophily (Colleoni et al., 2014). These influences, whether from industry, political leaders, or social media, may inspire people to develop environmental beliefs based on their existing political values.

This study focuses on a specific causal nexus within the broader framework: the relationship between political values and beliefs, and on a specific context for the causal nexus, how a college education may affect the relationship. The study addresses the following fundamental research question: what effects, if any, does exposure to knowledge about climate change in the college education (understood here as a four-year education following secondary school and leading to a bachelor's degree) have on belief in climate change? To answer this research question, the study builds on existing research on climate-related belief and education. As noted above, people who hold conservative political values tend to be less affected by education. In other words, for political conservatives, more education is not necessarily associated with an increase in belief in climate change. These studies include outcome measures such as belief in global warming, global warming as a threat, and climate change (Hamilton, 2011; Hamilton et al., 2010; Hamilton and Keim, 2009; McCright and Dunlap, 2011b). In general, they suggest that for political conservatives a college education is associated with a smaller increase in belief, or even a decrease in belief, in comparison with those with a politically left or progressive orientation. Originally documented in the U.S., subsequent research has extended the pattern to Europe (Krange et al., 2019). These studies provide intriguing information about the effects of a college education on climate-related belief, and the current study builds on the research by exploring in more detail the mechanisms by which the effects do and do not occur.

This study delves into the relationship by developing a detailed analysis of two of the primary mechanisms that could affect the relationship between political values and climate-change belief. One mechanism is that conservatives may self-select out of courses that have environmental, sustainability, or climate-related content (selective exposure bias), and another mechanism is that when conservatives are exposed to such information in courses, they may reject the information if it is perceived to be inconsistent with their values (resistance to belief change). This study explores in more detail the relative role of these two mechanisms.

With respect to the first mechanism, "selective exposure bias" is understood as a type of confirmation bias (Nickerson, 1998) that involves avoiding courses with climate-change content if a person already holds views associated with the rejection of climate science. There is a substantial literature on confirmation bias, that is, a cognitive process in which people choose not to expose themselves to information that will challenge their current values and beliefs (e.g., Hart et al., 2009; Stroud, 2010). Drawing on this literature, one can presume that people who are skeptical about climate change may be less likely to take environmental or climate change-related courses. In particular, people with defensive motivations who desire to protect their strongly-held values and convictions that climate change is not real may be particularly likely not to take a course that includes climate-change content (Hart et al., 2009).

However, a second mechanism may also be important. "Resistance to belief change" is understood as the discounting of climate-change information even when a person is exposed to it. For example, a student may avoid taking a climate-related course (selective exposure bias), but even if a student takes a course with climate-related information in it, this second mechanism may cause the student to ignore or to reject the information. Resistance to belief change, like selective exposure, is particularly likely among those with strongly held values and attitudes (Ahluwalia, 2000; Eagly and Chaiken, 1995). In other words, rather than change beliefs that are in conflict with core values, people may discount the new information in order to preserve their core values and the network of existing values and beliefs. In addition to directional motivated reasoning, a person may also reject the information because of a perception that the information source is not credible (Druckman and McGrath, 2019).

By exploring ways to measure both selective exposure bias and resistance to belief change in the context of a college education, and by measuring the effects of these factors, this study makes a contribution to the literature in the social psychology and sociology of environmental beliefs. The study will also assess whether one, both, or neither mechanism plays a role in change or stasis of climate change belief for conservative students during the course of a college education.

2.2. Contribution to sustainability and higher education studies

In addition to the theoretical contribution outlined above, this study also contributes to the sustainability and higher education literature, and in doing so the study offers potential implications for higher education policy. With respect to the sustainability and higher education literature, researchers from North America and Europe have documented the general lack of exposure of students to courses on sustainability and climate science (Ceulemans et al., 2011; Fisher and McAdams, 2015; Wolfe, 2001). Researchers have

also documented substantial variation in exposure across schools within a university, ranging from 80% of offered courses to 3% in one university in the U.K. (Lozano, 2010). The documented lack of exposure to courses on sustainability, the environment, or climate change has led some researchers to suggest the need to include environmental education as part of the required core curriculum (Hess and Collins, 2018). However, even where such courses are included in curricular requirements, the literature on sustainability in higher education indicates a need to assess and to improve exposure to different sustainability topics and methods in such courses (Watson et al., 2013). Part of that assessment should include the likelihood of exposure to such courses and the effects of exposure on belief.

With respect to the effects of exposure on beliefs, the literature suggests that in general sustainability-related courses have an effect on students' knowledge and beliefs. For example, students in environmentally-related college majors (such as zoology) tended to have a higher score on a general measure of environmental belief and concern (Shephard et al., 2015). Moreover, Fisher and McAdams (2015) found that even one course related to sustainability significantly affected a student's knowledge of the topic, and they also suggested that multiple courses may not affect sustainability perceptions in comparison with one course. In other words, from a curricular policy perspective, a single course requirement may be adequate to have an effect on belief. In a survey of the environmental literacy requirement in 58 courses, Moody and Hartel (2007) also found that taking such a course increased student knowledge (76%) and concern (65%) about environmental issues.

Combining the two groups of studies, there is general evidence that exposure to sustainability courses in higher education is low but that taking a sustainability course in college will lead to an increase in a student's beliefs about sustainability and environmental issues. However, to date research on sustainability in higher education has not examined the effects on belief across political orientation when students are exposed to a course that includes climate-change content. Thus, this study advances the literature on sustainability in higher education by bringing to it a perspective informed by research on political orientation and climate belief.

The present contribution to this literature is not merely of scholarly interest; it has implications for curriculum reform efforts and the sustainability curriculum in higher education. If the weak or null effect of education on conservatives' climate belief is because they self-select out of climate-related courses, then the policy implication is that climate science education should be required. However, if the mechanism is that conservatives have resistance to belief change because the information is in conflict with their political values, then it might be better to explore other ways of affecting climate change belief than the college education, or it might be better to explore other ways of affecting belief for students while they are in college. In other words, this study will contribute to the assessment of the potential effects of requiring climate education as part of the college curriculum, especially for students who have a conservative political identity and are skeptical or unsure about climate science.

2.3. Research hypotheses

To make the contributions described above, the research is based on a survey of college-educated U.S. adults to test two hypotheses:

Hypothesis 1 (selective exposure bias). College students who self-identify as political conservatives will show evidence of selective exposure bias against taking a course that has environmental or climate-change content.

Hypothesis 2 (resistance to belief change). For college students who self-identify as political conservatives, exposure to at least one course that has climate-change content in it will not increase the level of their belief in climate change.

The two hypotheses are not mutually exclusive. In other words, a college student may show evidence of both selective exposure bias and resistance to belief change. The theoretical model is portrayed visually in Fig. 1, with a positive or negative sign indicating the predicted relationship.

3. Method

3.1. Data source

A survey was developed for people located in the U.S. who graduated from college. The central survey questions related to the dependent and independent variables are listed in Appendix 1. Respondents were asked questions about their college education and their beliefs at the beginning and end of college regarding political ideology, political party, and climate change. The survey was limited to people who graduated from college in 2009 through 2018 and for "rising seniors," that is, people who planned on graduating in 2019.

The survey was administered in June and July, 2018, in two waves through Amazon Mechanical Turk (MTurk). The data source offers both advantages and disadvantages. The main advantage of the paid survey platform is that it overcomes the high barrier to entry of other survey platforms by making survey research costs accessible to a wide range of social scientists. One disadvantage is that online survey platforms do not provide a representative sample of the entire adult population of the country. For example, the MTurk platform tends to skew toward college-educated respondents who tend to be left-of-center politically. However, these two potential biases are of less concern for this study because the target population was limited to college-educated adults, the survey included questions about educational level and political values, and the survey examined the effects of the variables. A large sample size was also collected to ensure the collection of responses from an adequate number of conservative respondents. Furthermore, researchers in political science and psychology have often used MTurk to explore how ideology and political affiliation relate to individual behavior and beliefs (e.g., Buhrmester et al., 2018; Clifford et al., 2015).

Another potential disadvantage is that questions have also emerged about the quality of responses on MTurk. However, research has shown that other survey platforms are of similar quality even though their cost may be several times higher (e.g., Kees et al., 2017), and a review of assessments of MTurk found that it is of sufficient quality to be used for social science research (Paolacci and Chandler, 2014). To improve the quality of the data, the respondents were limited to people with a high reliability score

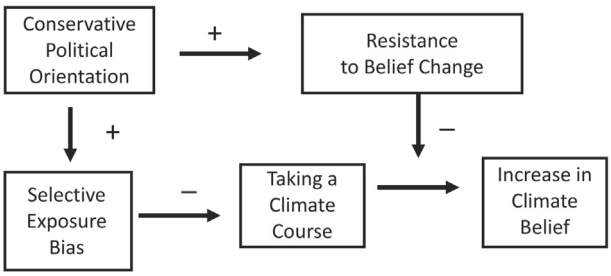


Fig. 1. Model of relations between variables.

on MTurk, and the data cleaning process carefully reviewed several questions that provided quality control. Incomplete responses, responses that were from the same location, and responses that did not meet the quality control tests were excluded. These tests involved examining qualitative answers for coherence and comprehension, and similar questions were used to compare consistency of response. After exclusion, the total number of responses was 1173.

A general limitation is that this is a recall study, and the recall design can introduce biases. However, the only complete solution to recall bias that examines the effects of college courses on beliefs is to have a pre- and post-design for a single course or to have a much larger study with a prospective design that follows students over the entire college education. The former option is limited in representativeness, and the latter is prohibitively expensive and time consuming. To reduce recall bias, the survey suggested that respondents use transcripts, and one-third of the respondents used transcripts. Thus, this variable provided a test for possible effects of recall bias.

3.2. First hypothesis: dependent and independent variables

For the first hypothesis, the dependent variable was whether or not a student took a course related to climate change in college. (Unless otherwise noted, the variables are unique measures developed for this study to test the hypotheses.) Three measures were used. “ClimCourse” (taking a climate-related course) was a binary variable coded as “1” in response to a question that asked the respondent to list any courses taken in college that included climate change (See Appendix 1 for the wording.). The two co-authors read the list of courses for each of the respondents and assigned a score of 1 if the list included courses that plausibly included climate science, such as earth science, ecology, environmental studies, or a global issues or policy course. The kappa score (comparison between the coders) was 0.80, a relatively high score, and the two coders then met and reconciled scores that differed. If the answer to the question indicated that the respondent was not taking the question seriously or did not understand the question, the respondent was excluded from the survey. For example, the courses listed may have been a general list of courses taken.

The second and third dependent variables (EnvPref, for environmental course preference, and ClimPref, for climate change course preference) were in response to questions that asked the respondents if they would have wanted to take an elective course in college on the topic if they had had the opportunity. Respondents were asked to show the level of their interest in the topic (see appendix). For the multinomial regression models with EnvPref or ClimPref as the dependent variable, the highest value for those dependent variables indicated not having interest in taking a course (option “d” in the question), and the lowest value indicated having clear interest in taking a course (option “a” in the question). This meant that in models analyzing EnvPref or ClimPref as the dependent variable, a positive predictor variable was linked to not wanting to take a course on that topic, and a negative predictor variable was linked to wanting to take a course on that topic.

The independent variable for the first hypothesis was conservative political orientation. The survey had two questions about political ideology, one for the beginning and one for the end of college, and two questions about political party identity, one for the beginning and one for the end of college. The three binary variables used in the study were for beginning political orientation because the initial view precedes course selection, and the initial view is most relevant for examining selective exposure bias. The three variables that measured beginning political orientation were very conservative (BegIdeoVC), conservative (BegIdeoAllC, a combination of all conservatives, that is, a combination of both very conservative and moderately conservative respondents), and Republican Party (BegPartyRep), each coded as 1.

3.3. Second hypothesis: dependent and independent variables

For the second hypothesis, the dependent variable was the change in belief in climate science, measured by two variables: ChBelief1 and ChBelief2 (see appendix). ChBelief1 compared the answers on two questions, one asking respondents to describe their level of belief in climate change at the beginning of college (ClimBegBelief) and one at the end of college (ClimEndBelief). The questions had five possible answers ranging from “climate change is real, humans are causing it, and humans can fix it” to “climate change is not real, humans are not causing it, and humans cannot fix it.” The structure of the answers was used in other climate belief studies and is considered a sound way to measure the different types of belief associated with climate change (e.g., Campbell and Kay, 2014). The questions enabled the construction of an ordinal variable for each answer, and ChBelief1 was the constructed by subtracting the beginning belief score from the end belief score, then adding 4 so that the scale ranged from 0 to 8. A high score indicated the greatest shift in belief toward “climate change is real, humans are causing it, and humans can fix it.”

The second dependent variable for this hypothesis, ChBelief2, was constructed based on a direct question that asked respondents if they took a climate-related course and if it affected their belief in anthropogenic climate change. Most answers were the first two options: no, they did not take a climate-related course, or yes, they did take a climate-related course but they already believed in anthropogenic climate change. For the remaining answers, an answer of c or d was coded as 1 and e as 0 (see appendix). Thus, ClimBelief2 compared the self-report of a taking a climate-change course only for people who began with a skeptical or unsure position. This question was added as the last question in the survey after the initial pilot of the survey; thus, the sample size for this question was smaller than for the rest of the survey ($N = 783$).

The independent variables were the political variables described above and whether or not a student took a course with climate change content (ClimCourse). These variables are described above. An interaction variable of beginning climate change belief (ClimBegBelief) and ClimCourse was also used to assess the extent to which taking at least one course with climate-related content had an effect on belief in climate change toward greater belief.

3.4. Control variables

The literature on climate change and education has drawn attention to the possible role of exposure to a core curriculum as a source of information about climate change (Hess and Collins, 2018), and the variable core curriculum (CoreCurric) in the college curriculum was included (1 = Yes). Likewise, it was reasoned that students who had some types of majors may also have a greater chance of gaining information about climate change. Thus, a second control variable (ClimMajor) was used. The variable assigned a value of 1 to social science majors and science majors that were deemed most likely to provide exposure to climate science (e.g., anthropology, biology, earth science, environmental studies, political science, sociology), and also to engineering majors, in comparison with all other majors. A third control variable was location. Because there is some evidence that the location of the college affects the percentage of climate-related courses available in a college (Hess and Collins, 2018), there was a control variable for the state in which the college education took place. The variable BlueState refers to the color symbolizing progressive

politics and strong state-government policies in support of energy transitions and climate change remediation. States coded as "blue" were those with generally Democratic Party control of the state legislature during the period of the college education for the respondents and with significant energy-transition policies such as a renewable portfolio standard (California, Connecticut, Colorado, Delaware, Hawaii, Illinois, Massachusetts, Maryland, Maine, Minnesota, New Jersey, New York, Oregon, Rhode Island, Vermont, and Washington). The two responses of people who indicated that they studied in Canada were also coded blue.

The research design also controlled for people who maintained their political orientation (or "lock in" of orientation) during the course of their college experience by using two other control variables, IdeoLock and PartyLock. If the beginning and ending response on questions for political ideology was the same, then IdeoLock was coded as 1, and nonmatching responses were coded as 0. Likewise, for PartyLock, matching responses for beginning and ending party identity were coded as 1.

For all models, the following demographic control variables were used: gender (male = 1), race (white = 1), Hispanic or Latinx ethnicity (1 = yes), parental education (ordinal), and current education (ordinal). These variables were selected because other studies have indicated that in the U.S. such demographic variables, especially gender and education, may be associated with belief in climate change (e.g., Hornsey et al., 2016; McCright and Dunlap, 2011a; McCright and Xiao, 2014).

3.5. Analytic strategy

For the first hypothesis, the dependent variable ClimCourse was analyzed using logistic regression given that the dependent variable only had two values (did or did not take a climate change course), and the variables EnvPref and ClimPref were analyzed using multinomial regression given that the dependent variables had four potential values. Only the definite "no" answer for EnvPref and ClimPref (would not have wanted to take such a course) is shown in the models because this answer provides the clearest comparison of preferences with the definite "yes" answer. For the second hypothesis, ChBelief1 had nine possible outcomes and was treated as a continuous variable and analyzed using traditional least squares linear regression models. The practice of treating this type of variable as continuous is standard in many social scientific fields (Norman, 2010). The second variable, CBelief2, did not have sufficient power for the independent variables to attain significance, and only descriptive results are presented.

Standard robustness tests were conducted (e.g., for collinearity, skewness, and kurtosis). The variable for transcripts (see above in the discussion regarding recall) was also used as a robustness check. It did not improve the models, was strongly linked to identifying as Hispanic (Latinx), and is not shown in the final models. An additional robustness test was conducted that deleted 46 responses where there were contradictions between the answer for ChBelief2 and ClimBegBelief. The models with the deleted responses were all consistent with the models in the full data set. Descriptive statistics are presented in Table 1, where the mean variable value (for continuous variables) or frequency of responses for each variable value (for categorical variables) can be found for all variables in the study.

Table 1
Descriptive statistics.

Variable	Mean value or percentage (if mean, standard deviation and scale range in parentheses)
Dependent:	
Took ClimCourse	46.9%
EnvPref	1.87 (0.95; 0–3)
ClimPref	1.82 (0.96; 0–3)
ChBelief1	4.09 (1.00; 0–8)
ChBelief2 - Course increased belief in climate change from skeptical or unsure	18.8%
Independent	
BegIdeoVC	11.1%
BegIdeoAllC	33.1%
LockIdeo	61.0%
BegPartyRep	34.8%
LockParty	79.9%
ClimBegBelief	3.22 (1.20; 0–4)
ClimEndBelief	3.31 (1.09; 0–4)
Controls	
Was a ClimMajor	36.3%
Had CoreCurric	94.2%
From BlueState	34.8%
Male	59.9%
Hispanic	15.0%
White	79.7%
ParentEduc	
Some high school or less	4.0%
High school or GED	16.7%
Some college	18.2%
College bachelor's	39.3%
Master's	16.3%
Doctorate	5.5%
SelfEduc	
Still completing college	13.8%
Bachelor's	63.9%
Master's	18.6%
Doctorate	3.7%

Key. CC = climate change.

4. Results

4.1. Hypothesis 1: selective exposure bias

Results were consistent across the models and supportive of the hypothesis that conservative students show selective exposure bias against taking a climate-related course (See Table 2.). For Models 1–3, both very conservative respondents and all conservatives (that is people who answered either very conservative or moderately conservative for their political orientation) were not significantly associated with taking a climate-related course in college (ClimCourse). However, consistency in the ideology (IdeoLock) from the beginning to end of college was negatively associated with taking such a course. In other words, respondents who did not change their political ideology in college tended not to take a climate-related course. Identity with the Republican Party and consistent identity with a party from the beginning to end of college (PartyLock) were both negatively associated with taking a climate-related course. Across all three models, respondents who studied in a college with a core curriculum tended to be more likely to take a climate-related course.

With respect to the direct question about their interest in taking an environmental course if they had an option to take an additional elective (Models 4–6), conservative students and Republicans were more likely to indicate that they did not think that the topic was interesting and important, and they would not have wanted to take a class on the topic. Respondents who majored in a subject classified as likely to have climate-related material indicated less opposition to taking such a course. Results were similar for the more specific question about their interest in taking a climate-related course (Models 7–9), except that very conservative students also indicated that they did not think the topic was interesting and important. Respondents who were in a program with a core curriculum also indicated less opposition to taking such a course.

Table 2
Analysis of selective exposure bias with respect to climate-related courses.

Model:	1	2	3	4	5	6	7	8	9
Dependent Var.:	ClimCourse (Yes)	ClimCourse (Yes)	ClimCourse (Yes)	EnvPref (Negative)	EnvPref (Negative)	EnvPref (Negative)	ClimPref (Negative)	ClimPref (Negative)	ClimPref (Negative)
Independent Var.:									
BegIdeoVC	-.220 (.197)			.414 (.288)			.616 (.273)*		
BegIdeoAllC		-.058 (.130)			.732 (.224)**			.897 (.217)***	
LockIdeo	-.286 (.124)*	-.295 (.124)*		.042 (.229)	.029 (.229)		.056 (.221)	.027 (.222)	
BegPartyRep			-.261 (.130)*			.607 (.225)**			.901 (.218)***
LockParty			-.586 (.152)***			.114 (.280)			-.120 (.280)
Control Variables:									
ClimMajor	.207 (.126)	.208 (.126)	.211 (.127)	-.487 (.238)*	-.525 (.239)*	-.495 (.238)*	-.680 (.226)**	-.724 (.227)**	-.702 (.227)**
CoreCurric	.984 (.300)**	.991 (.300)**	1.016 (.301)**	-.704 (.411)	-.715 (.413)	-.678 (.411)	-.864 (.396)*	-.894 (.398)*	-.839 (.397)*
BlueState	.124 (.129)	.131 (.129)	.108 (.129)	-.038 (.234)	-.036 (.234)	-.044 (.233)	.098 (.227)	.096 (.227)	.091 (.227)
Male	-.169 (.124)	-.170 (.124)	-.154 (.124)	.403 (.230)	.395 (.231)	.413 (.231)	.082 (.219)	.071 (.220)	.085 (.220)
Hispanic	-.408 (.175)*	-.416 (.175)*	-.323 (.177)	-.812 (.333)*	-.843 (.334)*	-.832 (.335)*	-.888 (.335)**	-.919 (.337)**	-.952 (.340)**
White	.125 (.152)	.125 (.153)	.129 (.153)	.020 (.272)	-.073 (.275)	-.027 (.274)	.135 (.268)	.025 (.272)	.059 (.271)
ParentEduc	.009 (.051)	.007 (.051)	.013 (.051)	-.073 (.093)	-.076 (.094)	-.074 (.093)	-.090 (.090)	-.092 (.091)	-.092 (.090)
SelfEduc	-.022 (.094)	-.028 (.094)	.025 (.095)	-.265 (.168)	-.280 (.168)	-.292 (.169)	-.047 (.162)	-.060 (.161)	-.093 (.162)
Constant	-.853 (.420)*	-.841 (.420)*	-.662 (.423)	.352 (.642)	.264 (.647)	.248 (.648)	.430 (.617)	.328 (.623)	.352 (.626)
Nagelkerke R^2	.037	.036	.051	.080	.080	.068	.073	.081	.070
N	1140	1140	1141	1161	1161	1162	1161	1161	1162

Key. Standard errors in parentheses. *p < .05. **p < .01. ***p < .001.

Although Hispanics (Latinx) indicated that they were comparatively less likely to have taken a climate-related course in college (Models 1–3), they also indicated that they would have been relatively interested in taking both environmental and climate-change courses (models 4–9).

4.2. Hypothesis 2: resistance to belief change

The analysis showed mixed evidence of resistance to belief change. For the dependent variable ChBelief1 (the comparison of climate-related belief at the beginning and end of college), the independent variable ClimCourse (evidence of having taken a climate-related course) was not significantly associated with ChBelief1 across all three models (See Table 3.). In other words, controlling for other factors, taking a climate change course is not associated with an increased in belief in climate change. However, the three measures of conservative political orientation—very conservative, all conservative (both very and moderate conservatives), and Republican respondents (as reported for the beginning of college)—all showed a significantly negative association with ChBelief1 in comparison with other political identities (moderate, progressive, and other respondents or, for party, Democrats and other party affiliations). Male respondents also showed a negative association with ChBelief1, and respondents whose education included a core curriculum showed a positive association with ChBelief1. Consistent with the hypothesis of resistance to belief change, these models indicated that conservatives do not increase their belief in climate change from the beginning to the end of college, even when controlling for having taken a climate-change course. Similar patterns were found in other models run as robustness checks.

However, the interaction variable of ClimCourse and ClimBegBelief shows a more complicated relationship. Given that this interaction variable was significant in all three models, follow-up

Table 3
Change in belief toward greater acceptance of climate change.

Model:	10	11	12
Dependent Variable:	ChBelief1	ChBelief1	ChBelief1
Independent Variables:			
BegIdeoVC	-.199 (.081)*		
BegIdeoAllC		-.115 (.055)*	
LockIdeo	-.098 (.051)	-.105 (.051)*	
BegPartyRep			-.187 (.054)***
LockParty			-.009 (.062)
ClimCourse	.039 (.050)	.041 (.050)	.042 (.050)
ClimCourse X ClimBegBelief	-.173 (.041)***	-.168 (.041)***	-.172 (.041)***
Control Variables:			
ClimMajor	-.019 (.052)	-.016 (.052)	-.020 (.052)
CoreCurric	.322 (.111)**	.328 (.111)**	.324 (.110)**
BlueState	-.088 (.053)	-.085 (.053)	-.094 (.053)
Male	-.112 (.051)*	-.110 (.051)*	-.115 (.051)*
Hispanic	.050 (.071)	.045 (.071)	.061 (.071)
White	.018 (.062)	.026 (.063)	.025 (.062)
ParentEduc	-.012 (.021)	-.012 (.021)	-.010 (.021)
SelfEduc	-.043 (.039)	-.047 (.039)	-.030 (.039)
ClimBegBelief	-.365 (.029)***	-.369 (.029)***	-.375 (.029)***
Constant	4.067 (.164)***	4.083 (.164)***	4.020 (.164)***
Adjusted R^2	.302	.301	.302
N	1140	1140	1141

Key. Standard error in parentheses. *p < .05. **p < .01. ***p < .001.

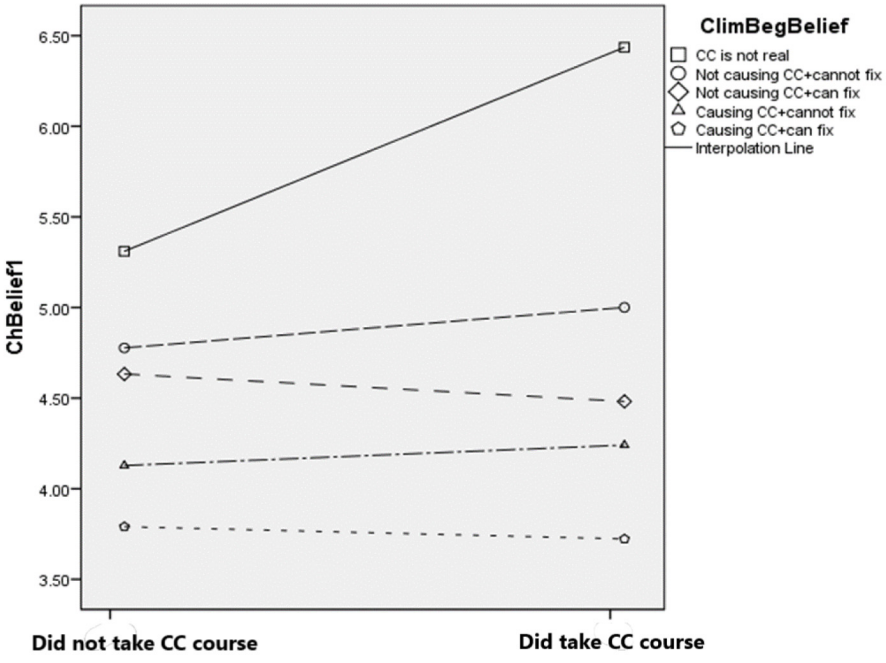
analyses using PROCESS (Hayes, 2017) were conducted to determine for whom taking a climate change-related course led to a significant change in climate change beliefs. The PROCESS tool is a macro for the Statistical Package for the Social Sciences (SPSS) that generates in-depth statistical information for tests of statistical moderation, such as for whom taking a climate change course led to change in beliefs. The analysis revealed that for the three models controlling for BegIdeoVC, BegIdeoAllC, or BegPartyRep, the only people for whom there was significant change in climate change beliefs were those people who previously did not believe in climate change (See Fig. 2 for an exemplar figure.). Across all three models, compared to those who did not believe in climate change and subsequently had not taken a climate change course, those who did not believe in climate change and subsequently took a climate change course increased their belief in climate change ($p < .001$; p-values across all other levels of initial climate change belief across all three models were $p > .14$). These analyses provide some evidence that for the most skeptical individuals, taking a climate-change course had a positive effect on their belief in climate change.

For the second measure of change of belief (the direct question, ChBelief2), the association between ChBelief2 and both ClimCourse and the political belief variables was also non-significant. However, a follow-up analysis again indicated that at least some conservatives were affected by exposure to a climate-change course. Of the Republican students who answered this question affirmatively (that they took a climate-related course, $N = 186$), 13.4% reported that it did not "change my belief from skeptical or unsure about climate science to thinking that climate change is real and that human greenhouse-gas emissions are a significant cause," but 31.3% reported a change from unsure, unaware, skeptical, or opposed to "thinking that climate change is real and that human greenhouse-gas emissions are a significant cause." The majority, 54%, reported no effect on their belief because they already accepted anthropogenic climate change. The percentages were similar for very conservatives and all conservatives. Thus, one-third of the Republican students who took a climate-related course reported that the course did result in an increase in their belief from an initial state of unsure or skeptical.

5. Discussion

The analysis provides evidence of selective exposure bias against both environmental courses in general and climate-related courses for students who self-identify as very conservative, very conservative or moderately conservative, and especially as a member of the conservative party. One implication of this finding is that all students should be required to gain some exposure to climate science as part of the general education requirements in higher education. Otherwise, some students, especially those with a conservative political orientation, will engage in selective exposure bias and lose the opportunity to learn more about climate science. Making this educational exposure a requirement would help to overcome selective exposure bias, which is one explanation of the finding that a college education is not always associated with stronger belief in climate change for conservative students (e.g., Hamilton, 2011; Krange et al., 2019; McCright and Dunlap, 2011b).

However, if all conservative students also were to show resistance to belief change, the educational requirement could still have a negligible effect on their beliefs. Thus, from a policy perspective it is important also to take resistance to belief change into account. The analysis provided evidence of some resistance to belief change among conservative students. Although the primary independent variable to measure resistance to belief change, ClimCourse, was nonsignificant by itself, an interaction variable that combined exposure to a climate-related course with beginning belief in climate change was significant. This interaction variable showed that respondents with the lowest level of beginning belief had a significant increase in belief if they had taken a climate-related course (controlling for ideology or party). The finding was



Key. CC = climate change.

Fig. 2. Exemplar interaction of taking a climate change course and beginning climate change belief predicting change in climate change belief.

consistent with frequency counts of self-reports of conservative students who began with an initial position of lack of certainty or rejection of climate science but reported a change in belief toward greater acceptance of climate science. Of conservatives who begin with a skeptical position and who took a climate-related course, more than twice as many showed an increase in their belief in climate change as those who did not. Thus, resistance to belief change is not ubiquitous even for conservative students who have rejected climate science as part of their political values and identity. Because resistance to belief change is not universal among these students, having a required college course could remedy confusion among more than half of conservative students who begin college with uncertainty or skepticism.

Furthermore, the study has implications for students of all ideologies and identities. Although most respondents indicated that they already believed in climate change at the beginning of college, 18.8% of students from all political orientations indicated that they had taken a course related to climate change and that it had changed their belief from unsure or skeptical to accepting that climate change is real and that human greenhouse-gas emissions are a significant cause. Thus, the study is broadly supportive of international reform efforts that would improve higher education by including a greater role for sustainability education in the college curriculum, and it suggests the importance of including climate-science education as part of the general sustainability education (e.g., Ceulemans et al., 2011; Fisher and McAdams, 2015; Lozano, 2010; Shephard et al., 2015; Wolfe, 2001).

6. Conclusion

The analysis presented here provides some general insights into the social psychological mechanisms of the relationship between education and climate-change belief by showing how both selective exposure bias and resistance to belief change have an effect on the change in climate belief as a result of college education. Although the study is limited to the effects of a college education on climate belief for conservatives in the U.S., it is likely to have generalizability to other countries, as indicated by previous replications of similar work in Europe (e.g., Krange et al., 2019). Moreover, the results of this study are of general, international interest because there is increasing evidence that conservative political parties across the world, especially those influenced by far-right populism, have shown opposition to climate-mitigation policies, and in some cases the leaders of the parties have also rejected climate science (Gillard, 2016; Hess and Renner, 2019; Lockwood, 2018; McCright et al., 2016; Young and Coutinho, 2013). Because international research also indicates that education is the leading predictor of climate-change belief (Lee et al., 2015), it is important to understand the mechanisms by which education does and does not affect climate-change belief.

A potentially important site for combatting the trend toward opposition to sustainability transitions and policies is through the college curriculum, where future leaders gain opportunities to acquire knowledge that allows them to resolve a lack of certainty about climate change and even to question a value-belief network associated with a conservative political orientation and rejection of climate change beliefs. One way to ensure that college students have the opportunity to resolve uncertainty or to overcome resistance to belief change is by having a curriculum that requires climate-change education. There are various pathways for accomplishing this goal.

One mechanism for embedding climate education in the college curriculum is through the core curriculum or general education requirement. Based on an analysis of a sample of catalog descriptions of courses, Hess and Collins (2018) indicated that where there is a core curriculum requirement, students had a 17% likelihood of taking a climate-related course if selection was random. Thus, having a core curriculum could decrease selective exposure bias because some students who might not otherwise select climate education would receive that education as part of their core courses. Indeed, in the present study, the CoreCurric and ClimCourse variables are positively and significantly correlated, albeit only modestly ($\rho = 0.116$, $p < .001$). But in addition to reducing selective exposure bias, a core curriculum could also widen intellectual horizons and make the students more flexible in their political ideology, thus reducing resistance to belief change. Indeed, in the present study, CoreCurric and LockIdeo are negatively and significantly correlated, although again very modestly at ($\rho = 0.069$, $p < .05$).

Thus, the results presented here are consistent with the suggestion that including climate change in the core curriculum or related curricular requirements could help to improve awareness of and belief in anthropogenic climate change. An even stronger suggestion would be to include a specific requirement to take a climate-related course as part of the core curriculum or as a general education requirement similar to a writing requirement or a foreign language requirement. This approach would reduce substantially the risk of losing students due to selective exposure bias that can occur when a climate-related course is part of a menu of core-curriculum options such as a required set of natural science or environmentally themed courses.

In summary, given the strong evidence for selective exposure bias, the evidence that at least some skeptical and conservative students who take a climate-related show an increase their belief in anthropogenic climate change from a position of uncertainty and skepticism, and the strong evidence that exposure to a core curriculum decreases selective exposure bias and increases belief change, it is reasonable to propose that having a climate-related requirement as part of the required set of courses for college students would likely help conservatives students to overcome skepticism or doubt about climate science. Many but not all conservative students who arrive in college misinformed or confused about climate science would benefit from exposure to such a course or courses, and students of all political identities would likely benefit. Moreover, a broad curricular reform movement to include more climate education in the college core curriculum could also help to reduce the politicization of climate belief and policy that appears to be increasingly widespread throughout the world by giving future leaders and voters the tools that they need to combat misinformation.

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Appendix

Selected Survey Questions for the Dependent and Independent Variables.

BegIdeo. When you were beginning college, how would you describe your political orientation? Choose the category that best describes your beliefs at the time.

a) Very conservative
b) Moderately conservative
c) Moderate
d) Moderately progressive or liberal
e) Very progressive or liberal
f) Unsure or apolitical

BegParty. When you were **beginning college**, what political party would best describe your affiliation? Choose the category that best describes your affiliation at the time.

a) Republican
b) Democrat
c) Independent
d) Other: Please explain.

ChBelief1. Difference between ClimBegBelief and ClimEndBelief. (Details provided above.)

ClimBelief2. Did you take any courses in college that had climate change as part of the course content?

a) No.
b) Yes, but the course or courses did not have any effect on my belief in the reality of climate change because I already thought climate change was real and that human greenhouse-gas emissions are a significant cause.
c) Yes, and the course or courses changed my belief from unsure or unaware to thinking that climate change is real and that human greenhouse-gas emissions are a significant cause.
d) Yes, and the course or courses changed my belief from skeptical or opposed to climate science to thinking that climate change is real and that human greenhouse-gas emissions are a significant cause.
e) Yes, and the course or courses did NOT change my belief from skeptical or unsure about climate science to thinking that climate change is real and that human greenhouse-gas emissions are a significant cause.

ClimBegBelief. When you began college, which statement from the following list best characterizes your opinion?

a) Climate change is real, humans are causing it, and humans can fix it.
b) Climate change is real, humans are causing it, and humans cannot fix it.
c) Climate change is real, humans are not causing it, and humans can fix it.
d) Climate change is real, humans are not causing it, and humans cannot fix it.
e) Climate change is not real.

ClimEndBelief. Same with “ended” replacing “began.”

ClimCourse. Take a minute to write down or recall any courses that you took in college that included climate change as a significant part of the syllabus. Again, by “course” we mean a class that you took for a semester, quarter, or year such as “US Environmental Policy” or “Introduction to Earth Science,” not a major or course of studies. By significant we mean about two or more weeks of coverage of climate change. This can include environmental courses that had significant coverage of climate change, and it can include social science courses that covered climate change and society or climate change and policy. If you did not take any courses in college that included climate change as a significant part of the syllabus, simply proceed to the next page. To receive compensation for taking this survey, do not answer with numbers, abbreviations, or gibberish terms.

ClimPref. When you were in college, if you had had a choice or option to take an additional elective course on specifically mentioned climate change or global warming, would you have wanted to take the course at the time?

a) Yes. I thought the topic was interesting and would have liked to learn more about it.
b) Maybe. The topic was interesting, but it would have depended on what the other options were.
c) Probably not, but mainly because I had other priorities and interests.
d) No. I didn't think the topic was interesting or important, and I would not have wanted to take courses about it.

CoreCurric. As part of your undergraduate degree requirements, did you have a core curriculum or a group of general education requirements? (Often this is a menu of distribution requirements, such as courses in the natural sciences, social sciences, writing, and humanities.)

a) Yes.
b) No.
c) Uncertain.

EndIdeo. Same as BegIdeo except for ended college.

EndParty. Same as BegParty except ended college.

EnvPref. Same as ClimPref except with “global environmental issues” replacing “specifically mentioned climate change or global warming.”

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